

## Bitter Lake

### Site Description

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#### **Location**

Water designation number (WDN)	22-0016-00
Legal description	T121N-R54W-Sec. 8-10, 15-17, 20-23, 27-29, 33, 34
County (ies)	Day
Location from nearest town	0.5 miles south of Waubay, SD

#### **Survey Dates and Netting Information**

Survey dates	August 30-31, 2012 (GN) September 26, 2012 (EF-WAE)
Gill net sets (n)	8
Electrofishing-WAE (min)	60

#### **Morphometry (Figure 1)**

Watershed area (acres)	71,248
Surface area (acres)	>15,000
Maximum depth (ft)	≈28
Mean depth (ft)	unknown

#### **Ownership and Public Access**

Bitter Lake is a meandered lake owned by the State of South Dakota and the fishery is managed by SDGFP. Two public access sites maintained by SDGFP are located on Bitter Lake (Figure 1; Figure 2). One located on the east shore off Day Co. Highway 1 includes a large parking area, double-lane concrete boat ramp, and dock; while the other located on the west shore off 442<sup>nd</sup> Avenue includes a smaller gravel parking lot, concrete-plank boat ramp, and dock.

#### **Watershed and Land Use**

Land use within the Bitter Lake watershed is primarily agricultural with a mix of pasture or grassland, cropland, and scattered shelterbelts.

#### **Water Level Observations**

No OHWM has been established by the South Dakota Water Management Board on Bitter Lake. The elevation of Bitter Lake on May 9, 2012 was 1802.9 fmsl and indicated an increase from the fall 2011 elevation of 1801.9 fmsl. The water level had declined to an elevation of 1801.6 fmsl on September 26, 2012.

#### **Fish Management Information**

Primary species	Walleye, Yellow Perch
Other species	Black Crappie, Common Carp, Northern Pike, Rock Bass, Spottail Shiner, White Bass, White Sucker
Lake-specific regulations	Walleye: minimum length 15"
Management classification	warm-water permanent
Fish consumption advisories	Mercury: Walleye (all sizes); Northern Pike (> 30"). See the South Dakota fishing handbook for more details on meal and portion size recommendations. Also see Department of Health website: <a href="http://doh.sd.gov/Fish/Default.aspx">http://doh.sd.gov/Fish/Default.aspx</a> for more information.

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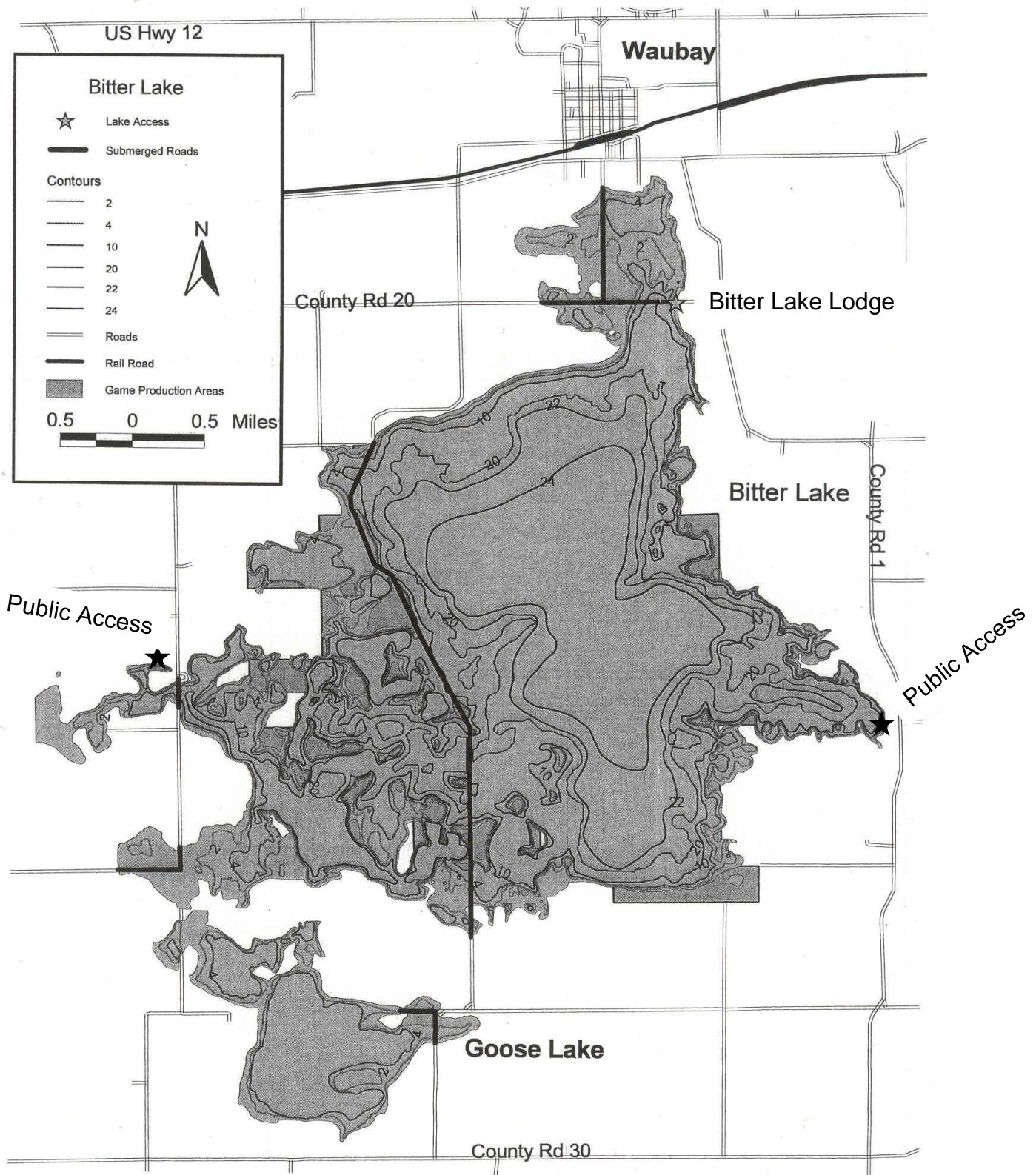


Figure 1. Bitter Lake, Day County, South Dakota contour map.





Figure 2. Map depicting geographic location of several Day County, South Dakota lakes including Bitter Lake. Also noted are public access locations and standardized net locations for Bitter Lake, Day County, South Dakota. BGN=gill nets

## Management Objectives

- 1) Maintain a mean gill net CPUE of stock-length Walleye  $\geq 10$ , a PSD of 30-60, and a PSD-P of 5-10.
- 2) Maintain a mean gill net CPUE of stock-length Yellow Perch  $\geq 30$ , a PSD of 30-60, and a PSD-P of 5-10

## Results and Discussion

Bitter Lake is a natural lake located south of Waubay, South Dakota in northeast South Dakota. Prior to the 1990's, Bitter Lake was a 3,000 acre alkaline slough with an approximate depth of 3 ft. High water conditions since the mid to late 1990's have increased the water depth and surface area of Bitter Lake. Currently, Bitter Lake covers in excess of 15,000 acres and is managed as a Walleye and Yellow Perch fishery.

### *Primary Species*

Walleye: The mean gill net CPUE of stock-length walleye was 19.8 (Table 1) and above the minimum objective ( $\geq 10$  stock-length Walleye/net night; Table 3). Since 2003, the mean gill net CPUE has ranged from a low of 9.1 (2008) to a high of 50.6 (2010; Table 2). The 2012 gill net CPUE was similar to the 2011 CPUE of 20.1 (Table 2), and indicated high relative abundance.

Gill net captured walleye ranged in TL from 26 to 69 cm (10.2 to 27.2 in), had a PSD of 58 and a PSD-P of 4 (Table 1; Table 3; Figure 3). The PSD was within the management objective of 30-60; while the PSD-P was slightly below the objective range of 5-10 (Table 3). At the time of sampling, approximately 43% of Walleye in the gill net catch were above the 381-mm (15-in) minimum length restriction and available for angler harvest (Figure 3).

Otoliths were collected from a sub-sample of gill net captured walleye. Seven year classes were present (2001, 2005, and 2008-2012) in the 2012 gill net catch, with the 2009 and 2011 year classes, which were naturally produced, being the most represented (Table 4; Table 6). The 2011 year class comprised 51% of walleye in the gill net catch; while the 2009 cohort accounted for an additional 35% (Table 4). Recruitment of Walleye from the strong 2011 year class coupled with the capture of fewer individuals from the 2009 cohort resulted in the reduced PSD observed in 2012 (Table 3; Table 4; Figure 3). The mean fall night electrofishing CPUE of age-0 Walleye was 36.0 (Table 1) and only eight age-0 Walleye were captured during in the 2012 gill net catch (Table 4). The relatively-low fall night electrofishing CPUE (Table 2) coupled with the capture of few age-0 Walleye in the gill net catch potentially indicates a weak naturally-produced year class in 2012.

Walleye in Bitter Lake exceed quality length and the minimum length limit (38 cm; 15 in) at age-3 (Table 5). Since 2005, the weighted mean length at capture for age-3 Walleye has ranged from 410 to 464 mm (16.1 to 18.3 in; Table 5). In 2012, the

weighted mean TL at capture of age-3 Walleye was 446 mm (17.6 in; Table 5). Gill net captured Walleye had mean  $W_r$  values that ranged from 82 to 91 for all length categories (e.g., stock to quality) sampled with the mean  $W_r$  of stock-length Walleye being 86 (Table 1). No length-related trends in Walleye condition were apparent.

Yellow Perch: The mean gill net CPUE of stock-length Yellow Perch was 67.3 (Table 1) and the highest CPUE observed from 2003-2012 (Table 2). The gill net CPUE was above the minimum objective ( $\geq 30$  stock-length perch/net night) and indicated high relative abundance.

Gill net captured Yellow Perch ranged in TL from 11 to 33 cm (4.3 to 13.0 in), had a PSD of 59 and a PSD-P of 40 (Table 1; Figure 4). The PSD was within the management objective of 30-60; while the PSD-P was above the objective range of 5-10 (Table 3). Otoliths were collected from a sub-sample of gill net captured yellow perch and age structure information suggested the presence of six consecutive year classes (2007-2011). The 2009 year class comprised 44% of Yellow Perch in the gill net catch; while the 2011 cohort accounted for an additional 42% (Table 7). Recruitment of Yellow Perch from the strong 2011 year class coupled with growth of individuals from the 2009 cohort to preferred-lengths resulted in size structure changes (i.e., reduced PSD and increased PSD-P) observed from 2011 to 2012 (Table 3; Figure 4).

Yellow perch in Bitter Lake exhibit fast growth and attain quality-length (20 cm; 8 in) by age 2 (Table 8). In 2012, the weighted mean TL at capture of age-1, age-2, and age-3 male Yellow Perch was 144, 223, and 232 mm (5.7, 8.8, and 9.1 in); while the weighted mean TL at capture of age-1, age-2, and age-3 female Yellow Perch was 157, 232, and 270 mm (6.2, 9.1, and 10.6 in), respectively (Table 8). Mean  $W_r$  values of stock-length Yellow Perch exceeded 100 for all length categories (e.g., stock to quality) sampled, with the mean  $W_r$  of stock-length Yellow Perch being 105 (Table 1). Yellow perch in the quality-preferred length category had the highest condition (i.e., mean  $W_r$  of 111); while Yellow Perch in the memorable-trophy length category had the lowest condition (i.e., mean  $W_r$  of 100).

### *Other Species*

Northern Pike: The mean gill net CPUE of stock-length Northern Pike was 5.0 (Table 1). The 2012 gill net CPUE represented an increase from the 2011 CPUE of 1.5 and was the highest CPUE observed since 2003 (Table 2). Currently, relative abundance appears to be high.

Northern Pike captured in the gill net sample ranged in TL from 48 to 84 cm (18.9 to 33.1 in), had a PSD of 98 and a PSD-P of 28 (Table 1; Table 3; Figure 5). Northern Pike condition was similar to that of Northern Pike captured from other northeast South Dakota glacial lakes (e.g., Lynn and Waubay Lakes), with mean  $W_r$  values that ranged from 84 to 88 for all length categories (e.g., stock to quality) sampled. Stock-length Northern Pike in the gill net catch had a mean  $W_r$  of 86 (Table 1) and no length-related trends in condition were apparent.

Other: Common Carp, Rock Bass, and White Bass were other fish species captured in low numbers during the 2012 fish community survey on Bitter Lake (Table 1).

### **Management Recommendations**

- 1) Conduct fish population assessment surveys utilizing frame nets and gill nets on an annual basis (next survey scheduled in summer 2013) to monitor fish relative abundance, fish population size structures, fish growth, and stocking success.
- 2) Conduct fall night electrofishing on an annual basis to monitor age-0 Walleye relative abundance.
- 3) Collect otoliths from Walleye and Yellow Perch to assess age structure and growth rates of each population.
- 4) Stock Walleye ( $\approx 500$  fry/acre) to establish additional year-classes if gill netting and/or fall night electrofishing CPUE of age-0 Walleye results warrant [i.e., low gill net CPUE of sub-stock ( $< 25$  cm; 10 in) Walleye and/or fall night electrofishing CPUE of age-0 Walleye  $< 75$  fish/hour].
- 5) Maintain the 381-mm (15 in) minimum length limit on Walleye. The regulation is designed to protect smaller fish from harvest and increase average fish size (Lucchesi and Blackwell 2009).

Table 1. Mean catch rate (CPUE; gill nets = catch/net night, electrofishing = catch/hour) of stock-length fish, proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish, and mean relative weight (Wr) of stock-length fish for various fish species captured in experimental gill nets and electrofishing in Bitter Lake, 2012. Confidence intervals include 80 percent ( $\pm$  CI-80) or 90 percent ( $\pm$  CI-90). COC= common carp; NOP= northern pike; ROB= rock bass; WAE= walleye; WHB= white bass; YEP= yellow perch

Species	Abundance		Stock Density Indices				Condition	
	CPUE	CI-80	PSD	CI-90	PSD-P	CI-90	Wr	CI-90
<i>Gill nets</i>								
COC	0.1	0.2	100	---	0	---	113	---
NOP	5.0	2.1	98	4	28	12	86	2
ROB	0.4	0.3	33	67	0	---	113	7
WAE	19.8	3.5	58	6	4	3	86	1
WHB	0.1	0.2	100	---	0	---	97	---
YEP	67.3	17.0	59	3	40	3	105	<1
<i>Electrofishing</i>								
WAE <sup>1</sup>	36.0	---	---	---	---	---	---	---

<sup>1</sup> Fall night electrofishing-WAE; catch rate (CPUE) represents age-0 walleye/hour

Table 2. Historic mean catch rate (CPUE; gill nets = catch/net night, electrofishing = catch/hour) of stock-length fish for various fish species captured using experimental gill nets and electrofishing in Bitter Lake, 2003-2012. BLC= black crappie; COC= common carp; NOP= northern pike; ROB= rock bass; SPS=spottail shiner; WAE= walleye; WHB= white bass; WHS=white sucker; YEP= yellow perch

Species	CPUE									
	2003	2004	2005	2006 <sup>3</sup>	2007 <sup>3</sup>	2008	2009	2010	2011	2012
<i>Gill nets</i>										
BLC	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.5	0.0
COC	0.2	0.0	0.1	0.0	0.3	0.1	0.0	0.3	1.4	0.1
NOP	1.5	1.3	0.4	0.8	0.3	0.4	0.5	1.0	1.5	5.0
ROB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
SPS <sup>1</sup>	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.1	0.0
WAE	25.8	17.9	20.0	31.8	16.9	9.1	11.0	50.6	20.1	19.8
WHB	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.1
WHS	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.3	0.3	0.0
YEP	2.2	2.9	2.6	11.8	2.6	4.1	20.8	25.9	39.0	67.3
<i>Electrofishing</i>										
WAE <sup>2</sup>	1.4	0.0	90.1	0.0	440.0	136.9	294.0	0.0	377.0	36.0

<sup>1</sup> All fish sizes.

<sup>2</sup> Fall night electrofishing-WAE; catch rate (CPUE) represents age-0 walleye/hour

<sup>3</sup> Monofilament gill net mesh size change (0.75", 1.00", 1.25", 1.50", 2.00" and 2.50")

Table 3. Mean catch rate (CPUE; gill nets = catch/net night) of stock-length fish, proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish, and mean relative weight (Wr) of stock-length fish for selected species captured in experimental gill nets from Bitter Lake, 2003-2012. NOP= northern pike; WAE= walleye; YEP= yellow perch

Species	2003	2004	2005	2006 <sup>1</sup>	2007 <sup>1</sup>	2008	2009	2010	2011	2012	Objective
<i>Gill nets</i>											
NOP											
CPUE	2	1	< 1	1	<1	<1	1	1	2	5	---
PSD	100	100	100	100	100	100	100	63	100	98	---
PSD-P	33	10	100	17	100	100	25	13	33	28	---
Wr	80	84	74	102	84	75	88	93	89	86	---
WAE											
CPUE	26	18	20	32	17	9	11	51	20	20	≥ 10
PSD	51	76	96	50	91	81	24	19	76	58	30-60
PSD-P	2	1	1	8	10	8	2	3	4	4	5-10
Wr	90	94	89	96	90	92	94	102	93	86	---
YEP											
CPUE	2	3	3	12	3	4	21	26	39	67	≥ 30
PSD	77	96	76	64	86	42	34	29	84	59	30-60
PSD-P	23	61	43	49	29	24	13	22	14	40	5-10
Wr	114	112	113	97	114	114	116	106	110	105	---

<sup>1</sup> Monofilament gill net mesh size change (0.75", 1.00", 1.25", 1.50", 2.00" and 2.50")

Table 4. Year class distribution based on the expanded age/length summary for walleye sampled in gill nets and associated stocking history (# stocked x 10,000) from Bitter Lake, 2008-2012.

Survey Year	Year Class													
	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999
2012 <sup>1</sup>	8	107	15	73	4			2				1		
2011 <sup>1</sup>	---	108	6	137	11	1		2			1	1	1	
2010 <sup>1</sup>	---	---	5	326	42	16		15		1	3	1		1
2009 <sup>1</sup>	---	---	---	123	53	15	3	13			1		1	1
2008 <sup>1</sup>	---	---	---	---	28	19	1	50			4	2	1	1
# stocked														
fry						1000		905					802	532
sm. fingerling														40
lg. fingerling														

<sup>1</sup> Older walleye were sampled, but are not reported in this table.

<sup>2</sup> Monofilament gill net mesh size change (0.75", 1.00", 1.25", 1.50", 2.00" and 2.50")



Table 5. Weighted mean TL (mm) at capture for walleye age-0 through age-10 sampled in experimental gill nets (expanded sample size) from Bitter Lake, 2005-2012. Note: sampling was conducted at approximately the same time during each year allowing comparisons among years to monitor growth trends.

Year	Age										
	0	1	2	3	4	5	6	7	8	9	10
2012 <sup>†</sup>	139(8)	252(107)	387(15)	446(73)	527(4)	---	---	592(2)	---	---	---
2011 <sup>†</sup>	155(108)	312(6)	397(137)	464(11)	473(1)	---	545(2)	---	---	653(1)	626(1)
2010 <sup>†</sup>	185(5)	307(326)	406(42)	443(16)	---	513(15)	---	561(1)	543(3)	635(1)	---
2009 <sup>†</sup>	133(123)	287(53)	358(15)	458(3)	474(13)	---	---	484(1)	---	496(1)	652(1)
2008 <sup>†</sup>	130(28)	271(19)	357(1)	431(50)	---	---	509(4)	510(2)	495(1)	598(1)	---
2007	170(1)	---	402(97)	---	466(3)	497(14)	484(6)	504(4)	455(1)	599(3)	544(6)
2006	191(1)	326(131)	413(5)	461(9)	468(66)	---	490(31)	509(5)	584(3)	442(4)	---
2005	165(64)	295(2)	383(7)	410(52)	429(47)	440(15)	455(14)	438(16)	478(2)	---	---

<sup>†</sup> Older walleye were sampled, but are not reported in this table.

Table 6. Stocking history including size and number for fishes stocked into Bitter Lake, 1999-2012. WAE= walleye

Year	Species	Size	Number
1999	WAE	fry	5,322,000
	WAE	fingerling	404,100
2000	WAE	fry	8,015,200
2005	WAE	fry	9,050,000
2007	WAE	fry	10,000,000

Table 7. Year class distribution based on the age/length summary for yellow perch sampled in gill nets from Bitter Lake, 2009-2012.

Survey Year	Year Class							
	2012	2011	2010	2009	2008	2007	2006	2005
2012	9	240	53	251	12	2		
2011	---	145	28	268	11	6		
2010	---	---		152	48	8		
2009	---	---	---	36	108	55	2	2

Table 8. Weighted mean TL (mm) at capture by gender for yellow perch captured in experimental gill nets (expanded sample size) from Bitter Lake, 2009-2012.

Year	Age					
	0	1	2	3	4	5
2012						
Male	126(10)	144(65)	223(28)	232(41)	---	---
Female	---	157(163)	232(22)	270(209)	303(12)	338(2)
Combined	126(9)	153(240)	226(53)	264(251)	303(12)	338(2)
2011						
Male	100(116)	163(10)	203(55)	---	---	---
Female	97(14)	174(15)	233(213)	292(11)	323(6)	---
Combined	98(145)	172(28)	227(268)	292(11)	323(6)	---
2010						
Male	---	161(31)	238(1)	231(1)	---	---
Female	---	175(117)	258(47)	294(7)	---	---
Combined	---	172(152)	257(48)	286(8)	---	---
2009						
Male	92(26)	165(7)	223(2)	---	266(1)	---
Female	92(10)	173(101)	239(53)	264(2)	---	---
Combined	92(36)	172(108)	238(55)	264(2)	266(2)	---

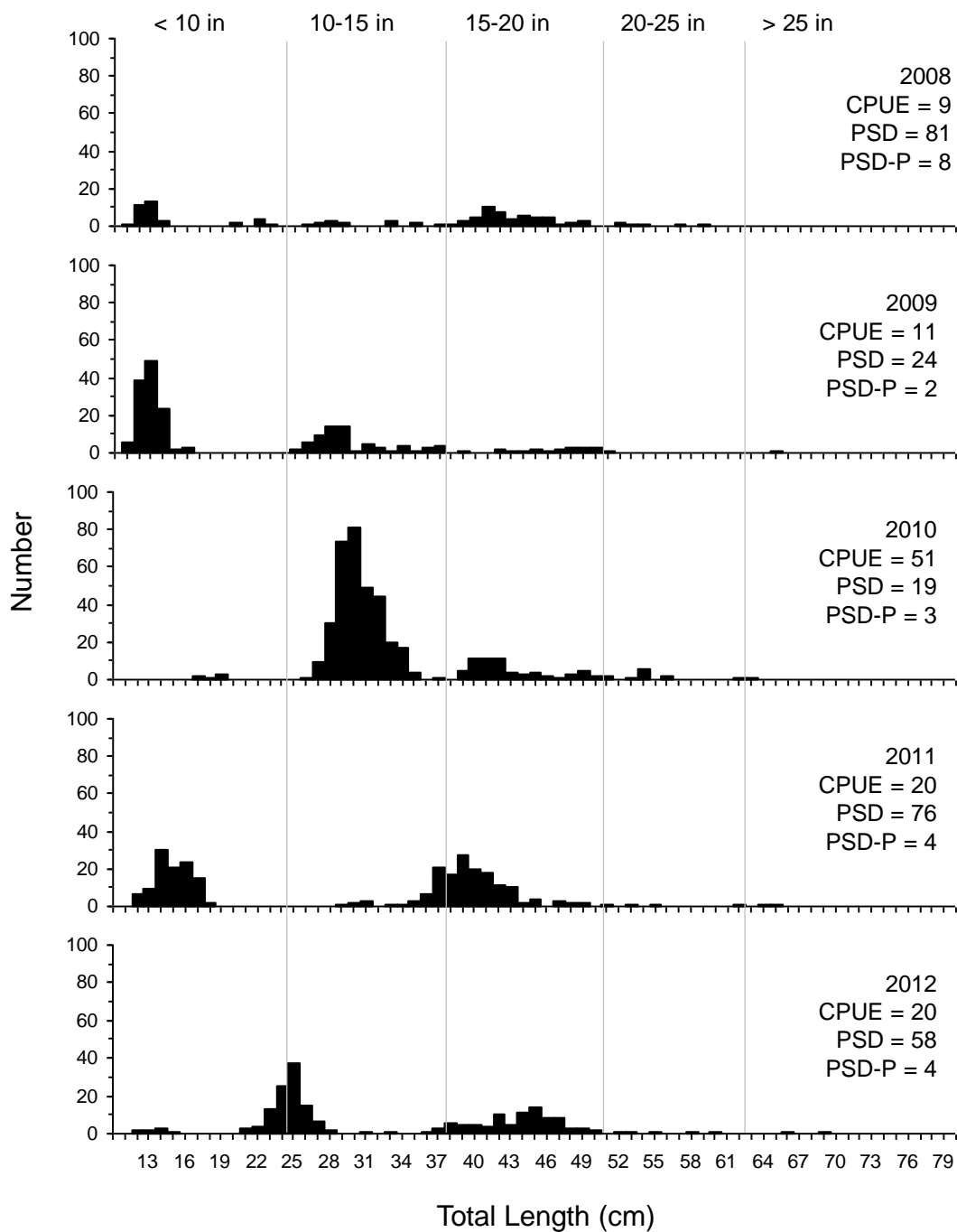


Figure 3. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for Walleye captured using experimental gill nets in Bitter Lake, 2008-2012.

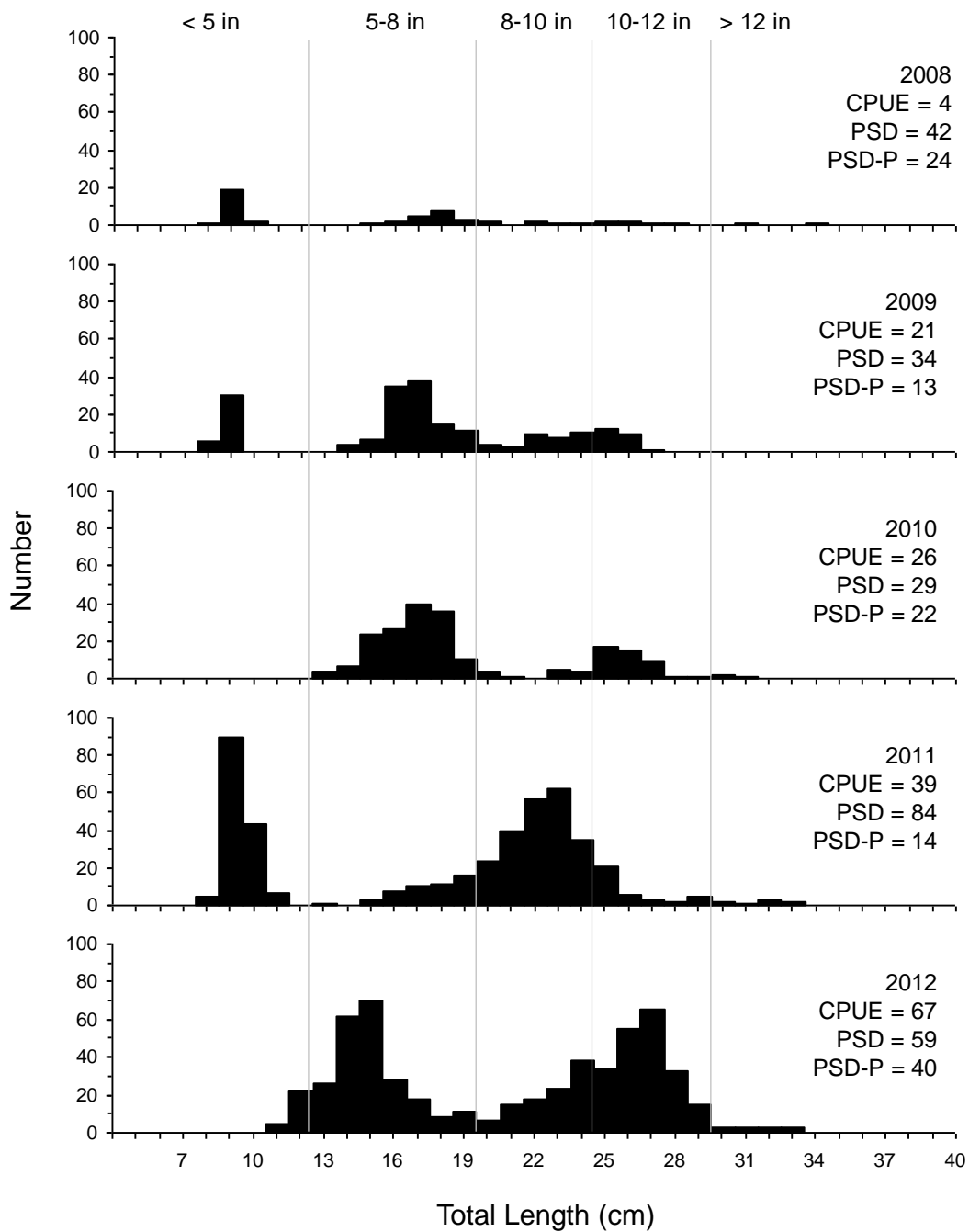


Figure 4. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for Yellow Perch captured using experimental gill nets in Bitter Lake, 2008-2012.

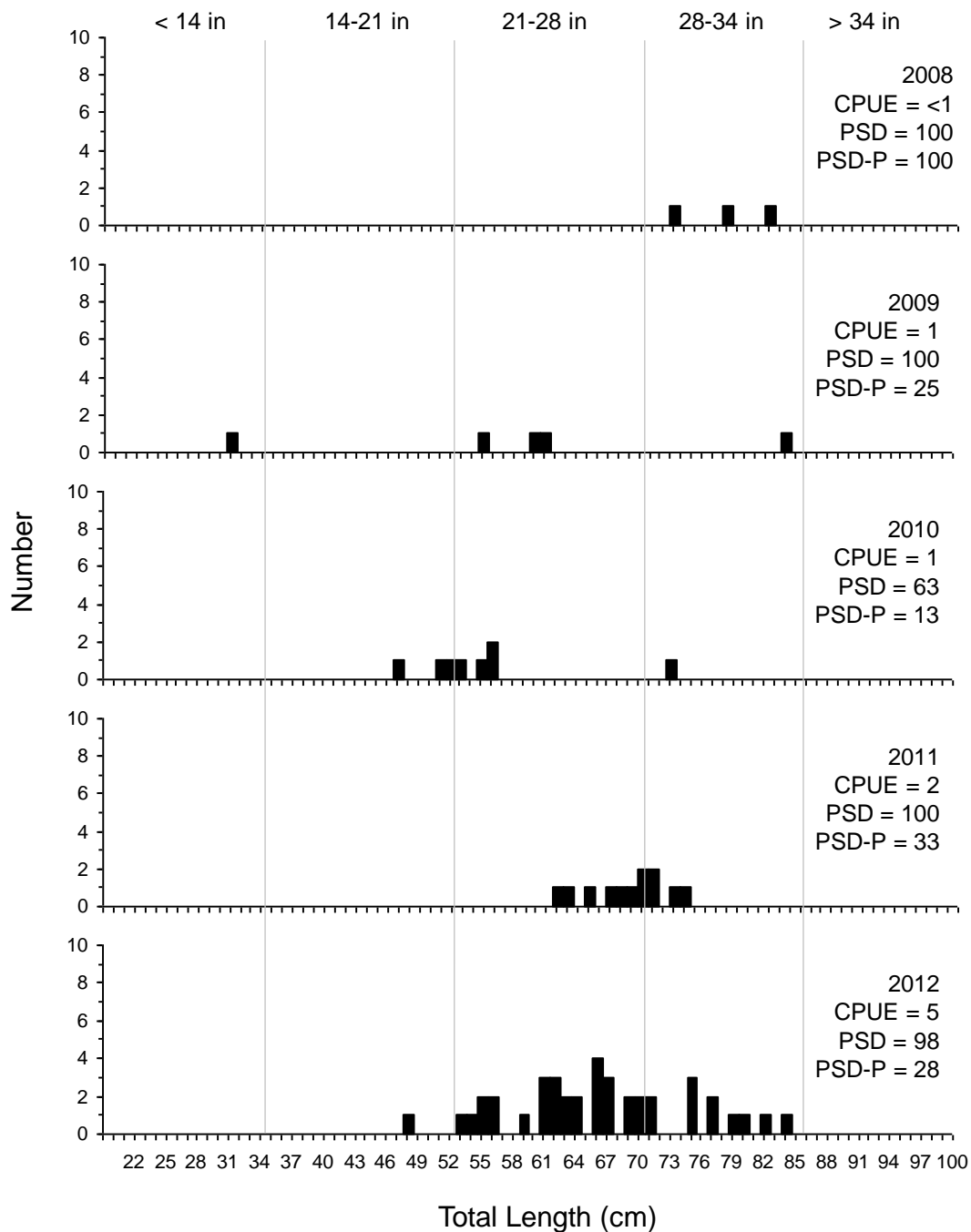


Figure 5. Length-frequency histogram, catch rate of stock-length fish (CPUE), proportional size distribution of quality- (PSD) and preferred-length (PSD-P) fish for Northern Pike captured using experimental gill nets in Bitter Lake, 2008-2012.